

Manure Storage Planning, Design, Construction, and Documentation

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LCBP, NEIWPCC, and EPA are funding partners

Assumptions

- More environmental controls on land use
 - Federal, State, Local
- More water quality emphasis
 - Winter spreading
 - P impact
- More air quality emphasis
 - Odor
 - GHG

Storage Changes

- Past
 - AAP
 - Management
 - NMP \$
 - Compaction?
 - Farm and Engineering rationale
- Now
 - RAP
 - Environmental
 - Regulatory
 - Community

Ideal Management

- Sized correctly based on CNMP
- Emptied according to plan
- Maximizes nutrients to fields
- Solids controlled
- Drainage area controlled
- Manure production stays same





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Actual Management

- Sized based on affordability
- May not be emptied according to plan
- Nutrients wasted
- Solids build up (or pump out limited)
- Drainage area increased
- Manure production increases
 - More cows
 - More production









Daily Spreading

Set your sights on this sharpshooter!

Daisy's Model 98—looks like the big "match rifle" the experts shoot. Approved for Boy Scout, Jaycee, NRA and A-H marksmanship training. Perfect for fun around home too—even on your own indoor range. All you need for safe shooting is 15 feet of space, a box filled with paper, a blanket behind it... and your Daisy!

Fixed front sight with 8 threads Adjustable rear sight Real wood "Woods Gully" style stock
Real wood "sawtooth" forearm Trigger with adjustable sling Lever action with 30-shot magazine

MODEL 98—Official JAYCEE Shooting Education Rifle.
About \$16.95

OTHER GREAT DAISY'S...

Model 26, "Spittin' Image" of a popular 22 gauge, about \$12.95

Model 189-L, "Spittin' Image" of famous western carlinos, about \$13.95

Other Daisy models from \$6.95 to \$13.95

Sign up today for the 1966 International B-B Gun Championship

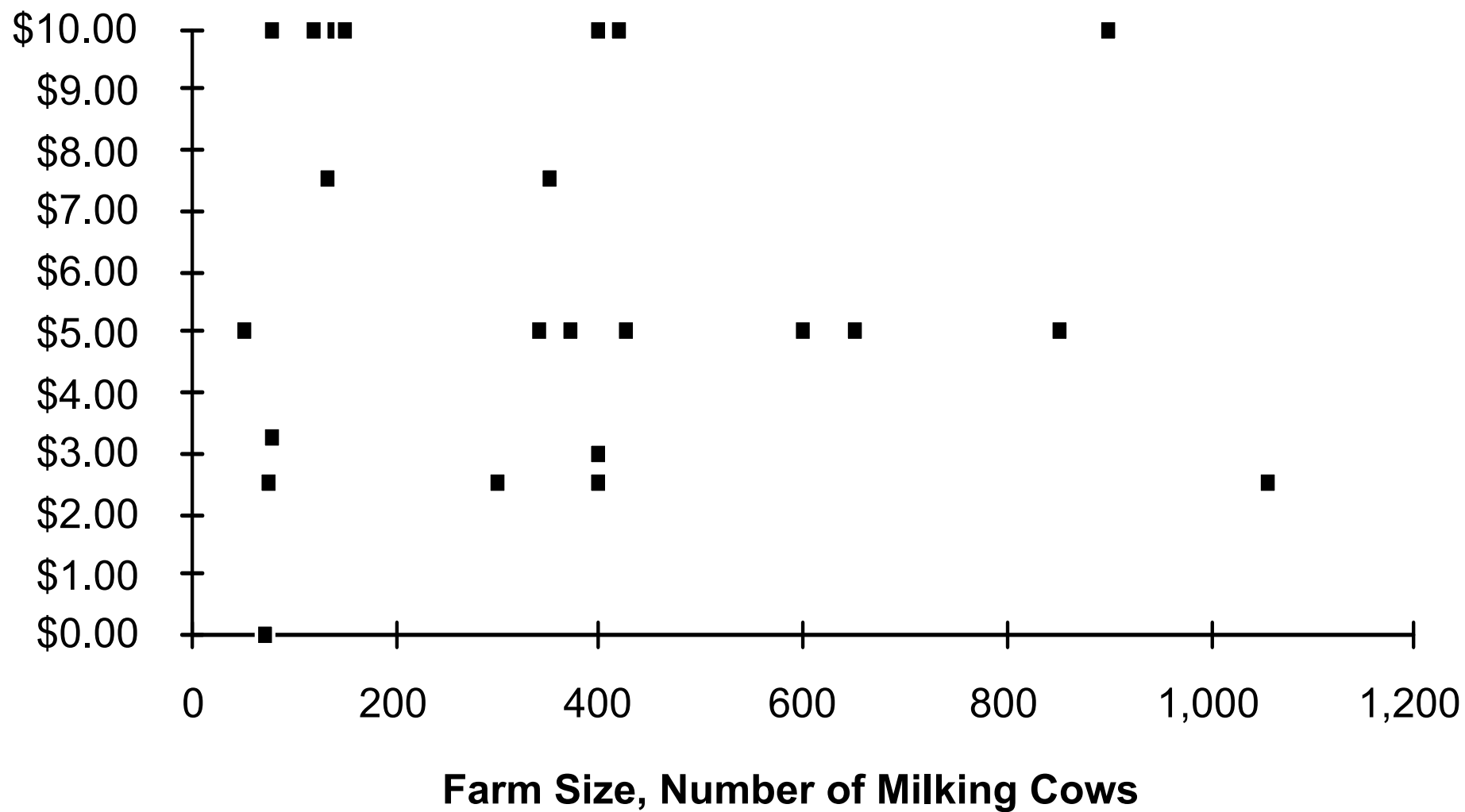
Sponsored by the U. S. Jaycee, Pouch July 8, 9, 10 in Dayton, Ohio—your expenses paid! Boys and girls, age 5-16, are eligible to participate. Contact the Jaycee Chapter in your town and join their (or shooting Education Program).

Daisy
MANUFACTURING COMPANY
Rogers, Arkansas 72756
(In Canada: Preston, Ontario)

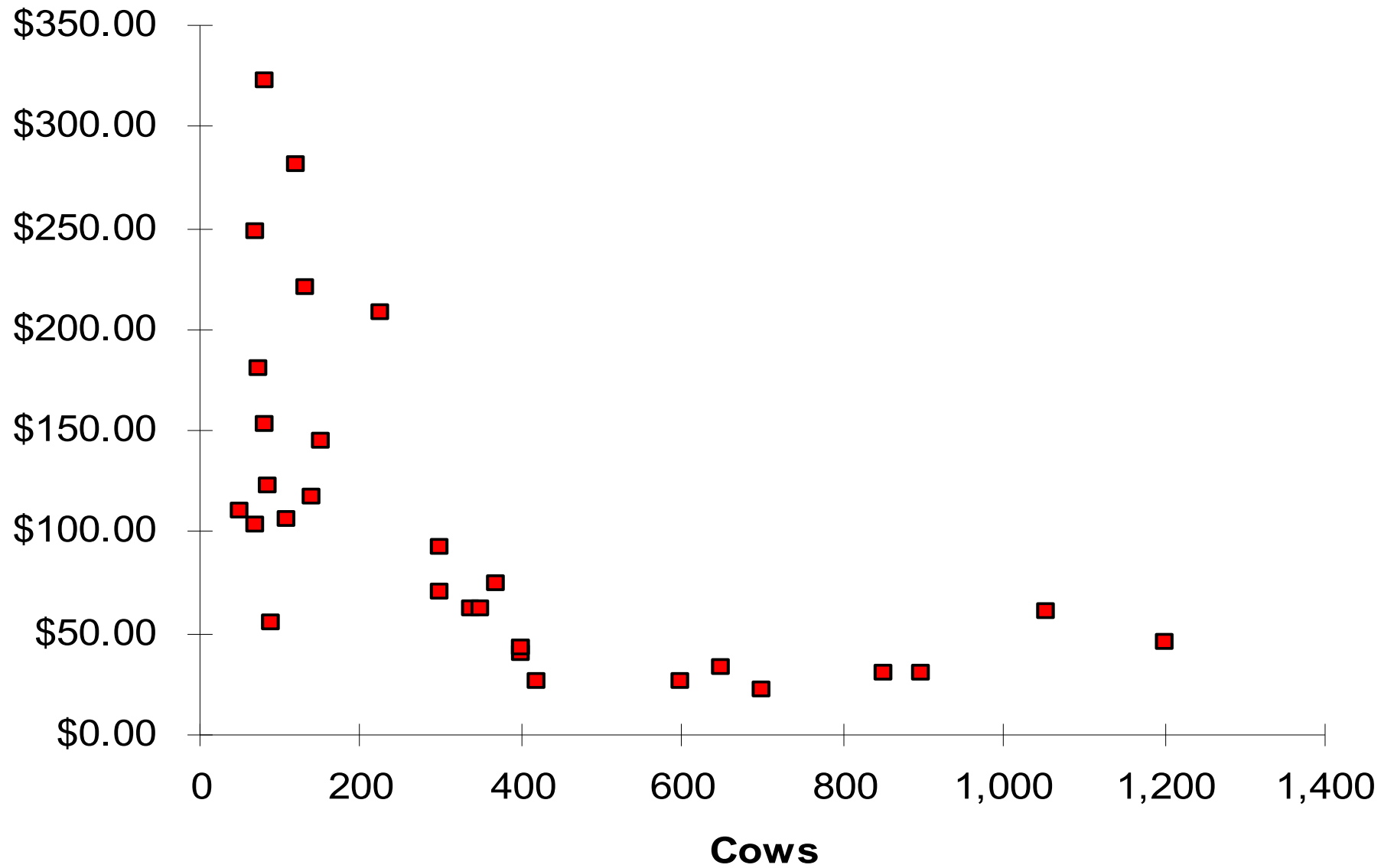
Manure Storage



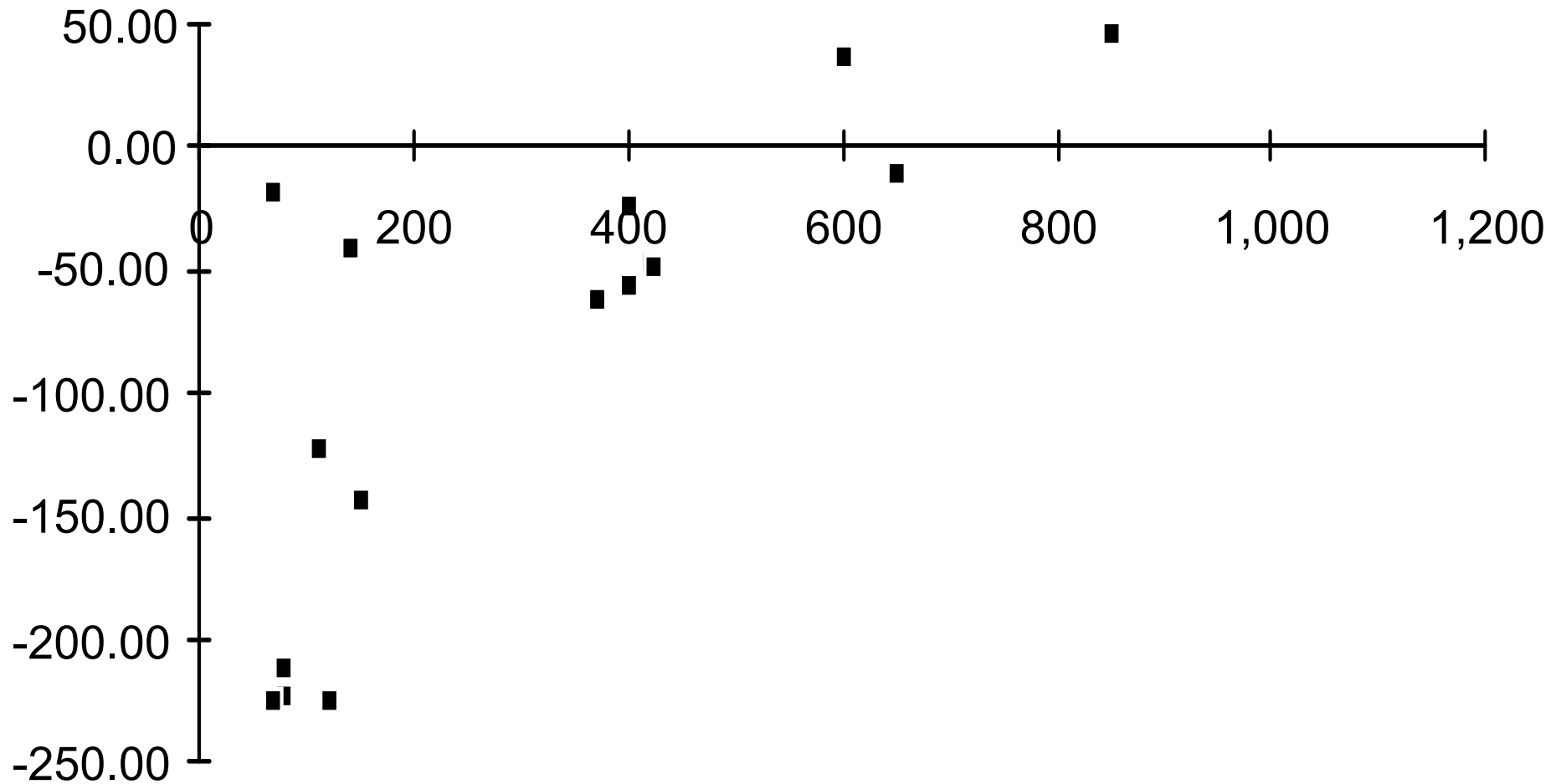
Estimated Manure Value, dollars per 1,000 gallons



Cost of Spreading / Cow

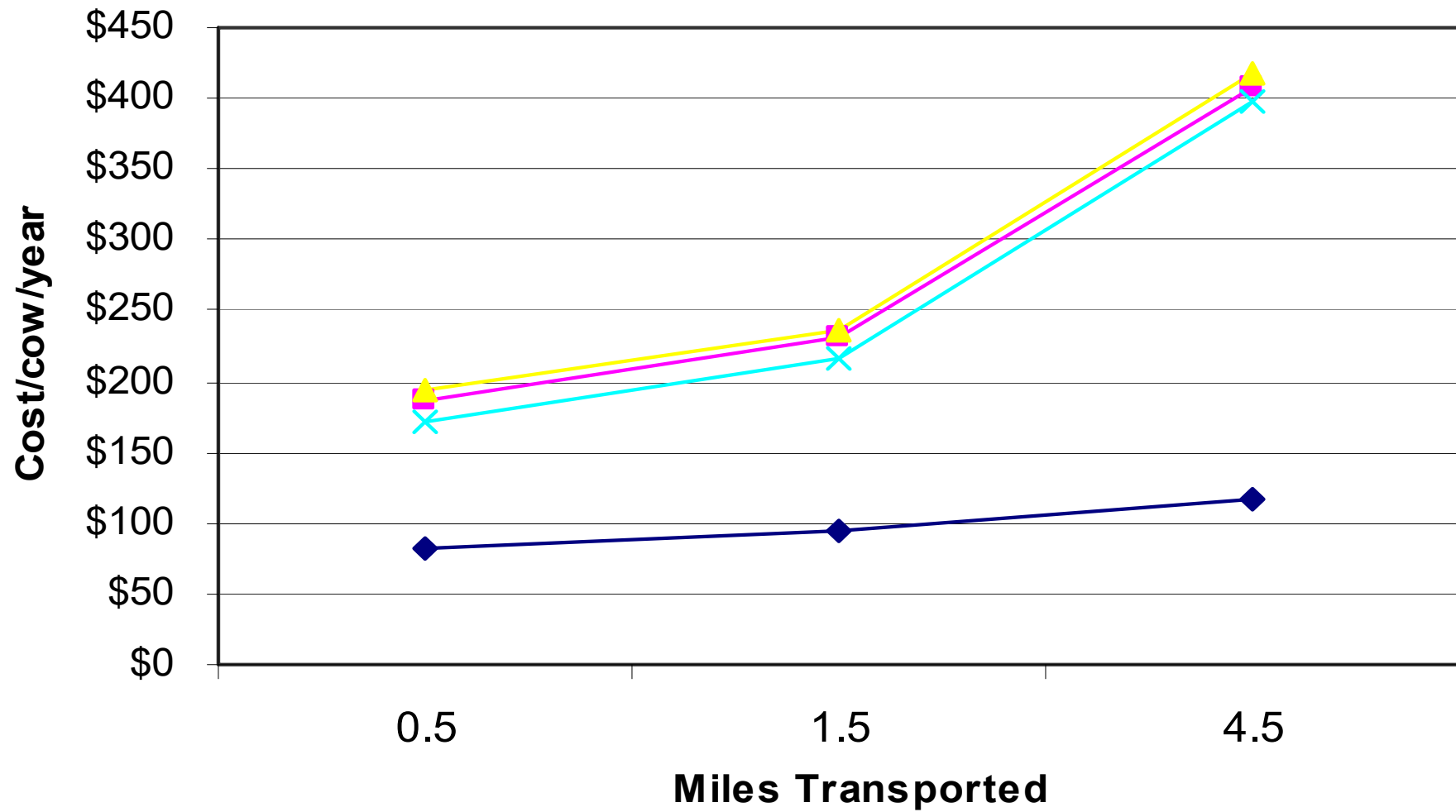


Value of Manure Spread, dollars per acre



Farm Size, Number of Milking Cows

Cost per cow for 50 cows



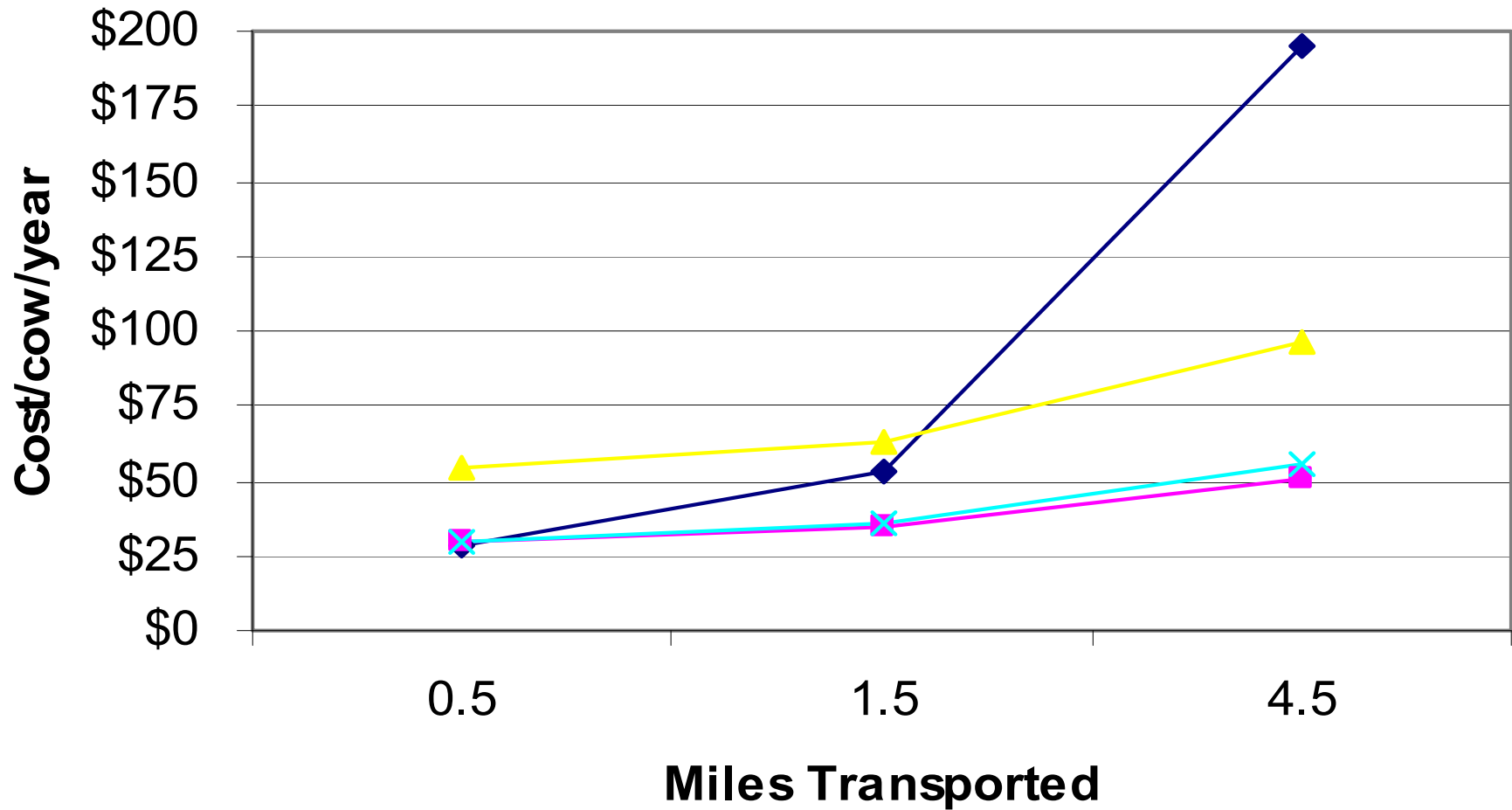
—◆— 5,000 gal. Tanker

—■— Drag Hose

—▲— Hard Hose

—×— Center Pivot

Cost per cow for 2,000 cows



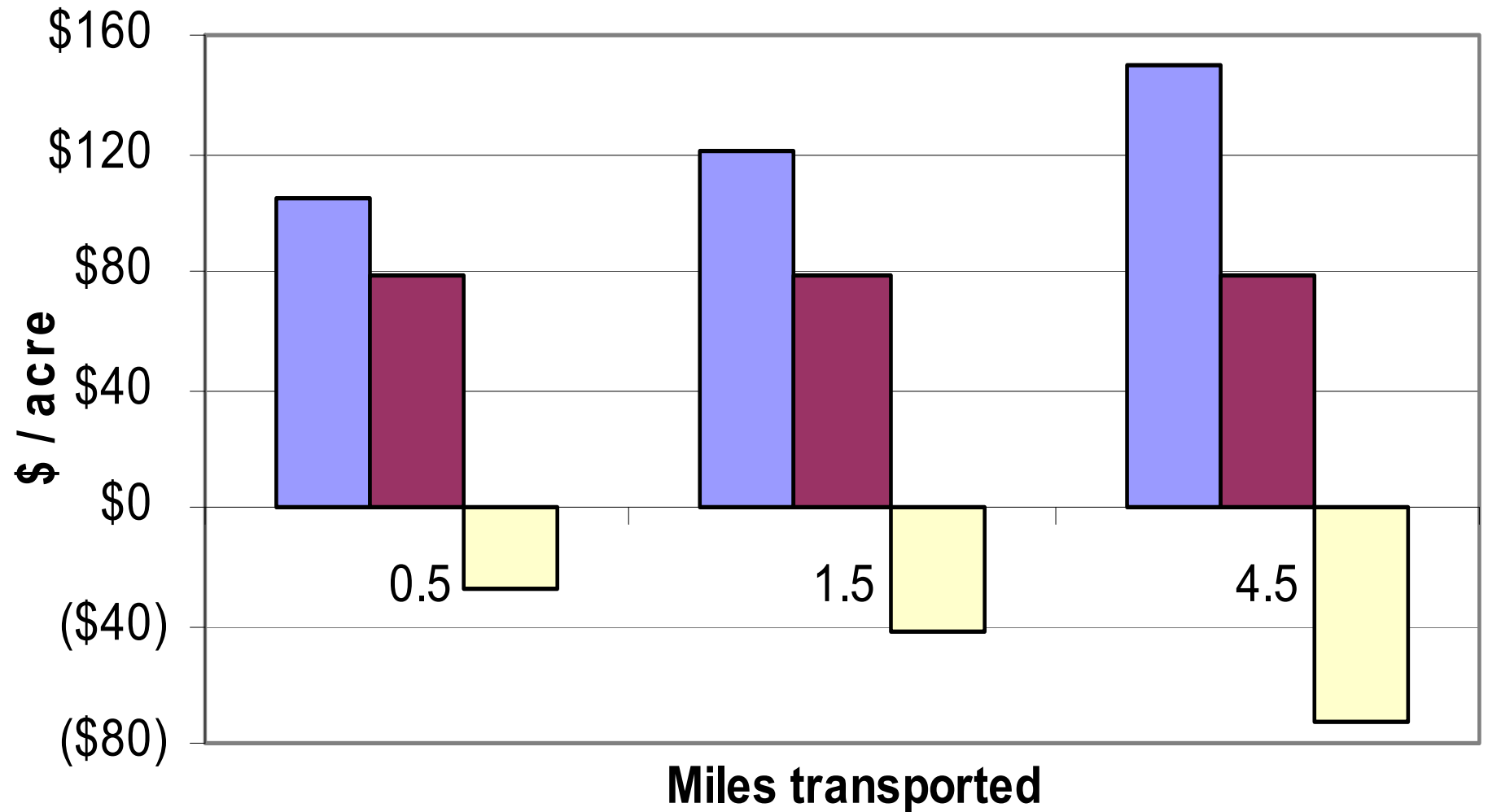
—◆— 5,000 gal Tanker

—■— Drag Hose

—▲— Hard Hose

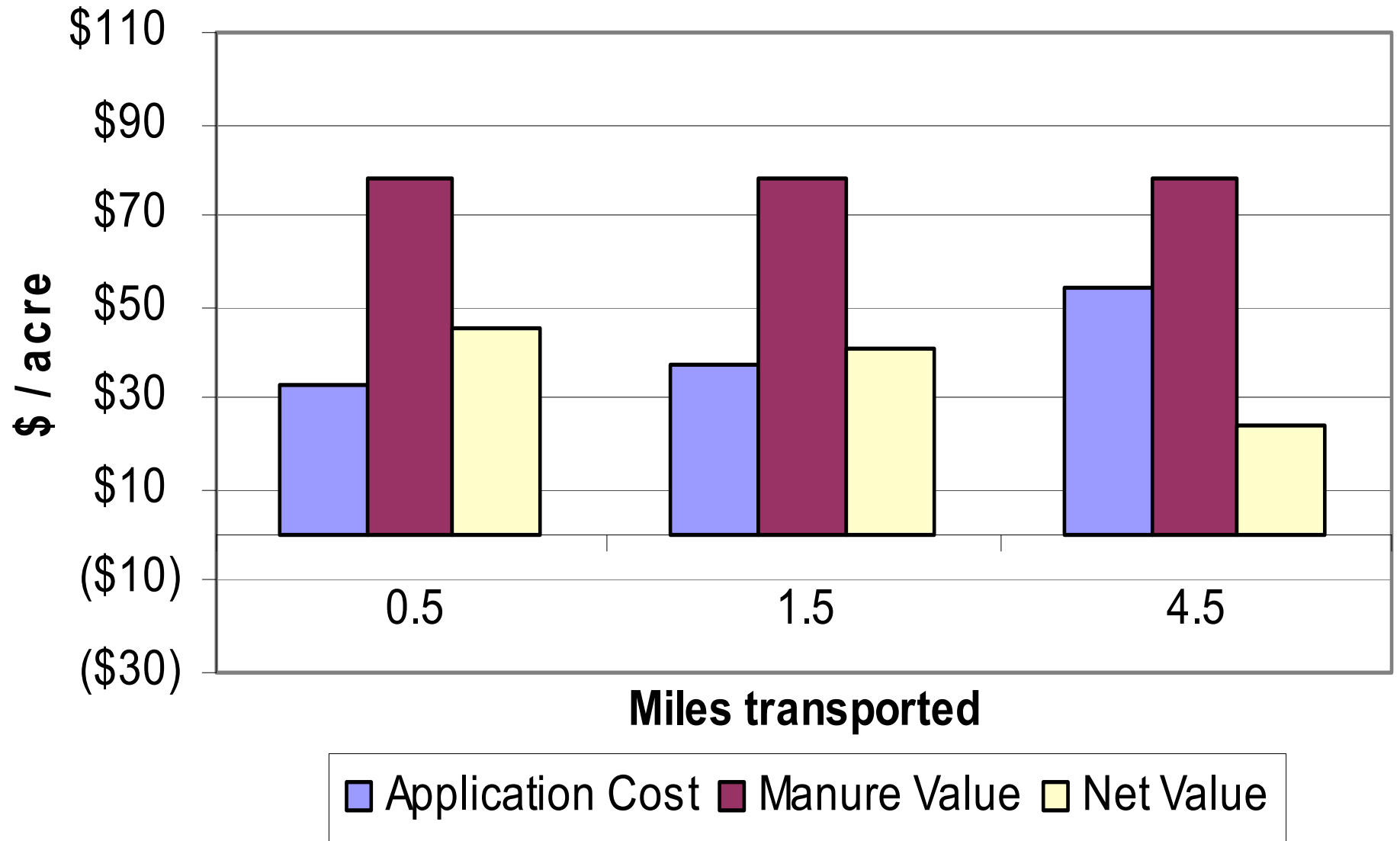
—×— Center Pivot

**Value/acre based on:
N application, 5000 gal. tanker, 50 cows**



■ Application Cost ■ Manure Value ■ Net Value

**Value/acre based on:
N application, drag hose, 2000 cow**



Intangible Values

- Organic Matter
 - Water holding capacity
 - Nutrient holding capacity
 - Soil Tilth
- Compaction
- Delayed Corn Planting and Hay harvest
- Environmental Risk
- Odors













Lesson 20

Planning and Evaluation of Manure Storage



By Charles Fulhage
and John Hoehne,
University of Missouri,
Columbia

<http://articles.extension.org/pages/8963/livestock-and-poultry-environmental-stewardship-curriculum>



Livestock and Poultry Environmental Stewardship



Planning with an Engineer

- Have a relationship
- Part of the Team
 - Used when needed
 - Operate under the direction of an engineer
 - (relationship)
- Spectrum of:
 - Planning design construction evaluation

Considerations in Planning and Managing Manure Storage

- Type of livestock and bedding used
- Manure collection and transport methods
- Desired or required treatment
- Nutrient conservation or loss characteristics
- Land application and nutrient utilization



Considerations in Planning Manure Storage

- Designed by a Professional Engineer Following NRCS Standards
- Buffer distances
- O&M according to CNMP and NRCS Standards
- Separation distances from sensitive water features



Considerations in Planning Manure Storage

(continued)

- Geological investigation of manure storage site
- Soils evaluation for liner construction
- Location relative to floodplain or water table
- Recording/reporting regular inspections

Summary

Planning and Evaluation

- Consider form or consistency of manure to be handled.
- Make a thorough site investigation.
- Ensure compliance with local, state, and federal requirements.

Sizing Considerations

- Type of operation (open vs. confined)
- Animal numbers and species
- Climatic characteristics (rainfall, evaporation)
- Facility type (lagoon vs. pit)
- Storage period
- Washwater use

Bedding Use

Table 21-3. Daily bedding use in dairy and swine housing systems, lbs bedding material per day per thousand pounds live animal weight.

Material	Dairy stanchion	Dairy freestall	Dairy housing	Swine structure
Loose hay/straw	5.4		9.3	15.0
Chopped hay/straw	5.7	2.7	11.0	—
Wood shavings, sawdust	—	3.1	—	18.0
Sand, limestone	—	20.0 - 35.0	—	—

Adapted from NRCS Animal Waste Facilities Handbook and MWPS AED 41, Hoop Structures for Grow-Finish Swine.

Siting Considerations Earthen Impoundments

- The use of soils to impound manure usually requires more extensive evaluation than a concrete or steel tank.
- Variability in soils may require a detailed soils investigation.
- A properly constructed soil liner should provide a nearly impermeable barrier.

Siting Considerations

Earthen Impoundments

Geological investigation assesses surface and subsurface geological characteristics that might negatively impact water resources.

Land slope
Topography
Soil type



Siting Considerations Earthen Impoundments

Geological Investigation

- Streams



Siting Considerations Earthen Impoundments

Geological Investigation

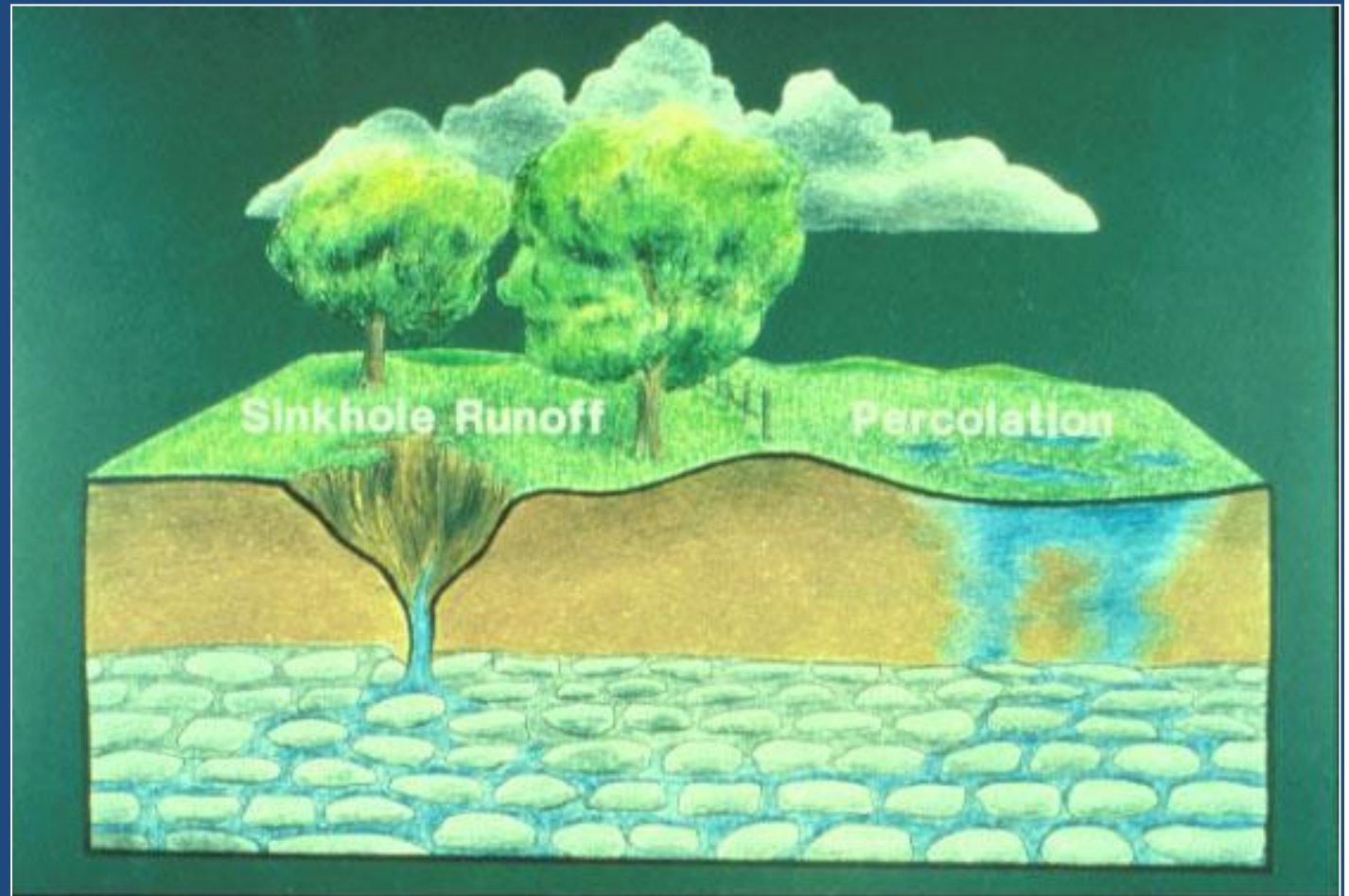
- Streams
- Lakes



Siting Considerations Earthen Impoundments

Geological Investigation

- Streams
- Lakes
- Aquifers



Siting Considerations Earthen Impoundments

Geological Investigation

- Bedrock



Siting Considerations Earthen Impoundments

Geological Investigation

- Bedrock
- Collapse potential



Siting Considerations Earthen Impoundments

Geological Investigation

- Bedrock
- Collapse Potential
- Sinkholes



Siting Considerations

Earthen Impoundments

Separation Requirements

Groundwater and surface water

- Vertical separation required between the bottom of the earthen impoundment and the seasonally high water table.
- Horizontal separation 300 up or 200 ft. required between earthen impoundments and water supply wells. 500 ft. from neighbor wells.
- Horizontal separation 200 ft. required between earthen impoundments and lakes, ponds, or reservoirs.



Separation Requirements

- Locating in a flood plain presents several risks.
 - Potential inundation by floodwater
 - Manure may be displaced from storage, creating an environmental liability.
 - Floodwater can exert an unbalanced hydraulic pressure that may compromise seal and embankment integrity.

Siting Considerations

Earthen Impoundments

Soil Test Borings/Test pits

- Provide information on subsurface soil type, depth to groundwater, depth to bedrock, presence of sand or gravel



Siting Considerations

Earthen Impoundments

Soil Test Borings/ Test Pits

- Number depends on geologic variability of site, usually a minimum of four locations.
- Depth usually a minimum of excavation depth plus 4 ft.
- Soil samples may be tested for permeability and/or other engineering properties.
- Test Pits may be performed by NRCS or private geotechnical/engineering firms.



Soils Considerations

Earthen Impoundments

Sealing Effect of Manure

- Many soils may partly seal due to manure particles plugging pore spaces.
- Salts in manure disperse soil particles, decreasing permeability.
- Soil structure may also be altered by biological processes.
- The effect of manure should NOT be expected to provide sufficient sealing by itself.



Soils Considerations

Earthen Impoundments

Seepage

- All earthen impoundments with a soil liner will have some seepage.
- NRCS's Agricultural Waste Management Field Handbook, Appendix 10D

Soils Considerations

Earthen Impoundments

Seepage described by Darcy's law

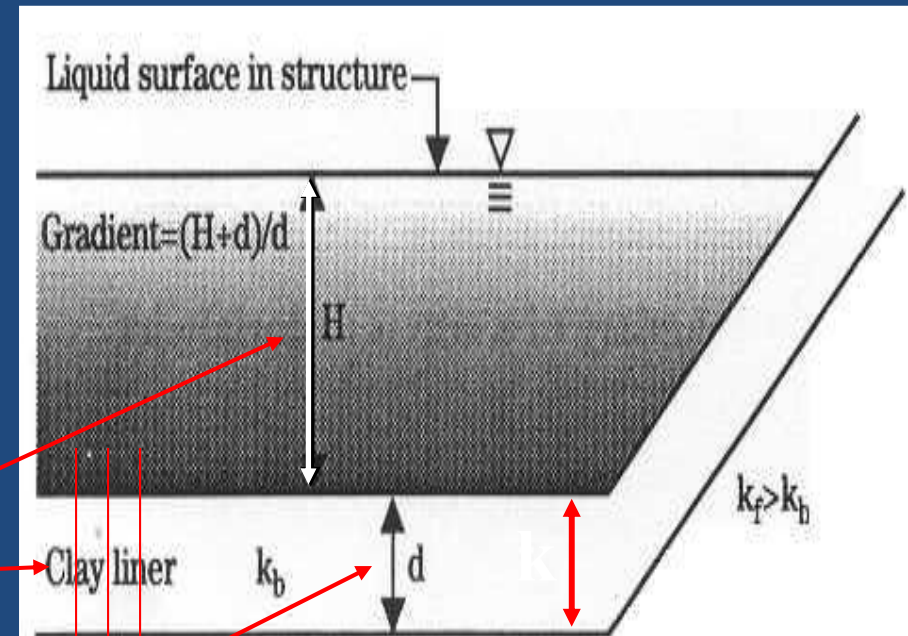
$$v = k (H+d)/d$$

v = seepage rate through liner

k = permeability coefficient of liner

H = liquid depth

d = liner thickness



clay liner

Soils Considerations

Earthen Impoundments

Seepage described by Darcy's law

$$v = k (H+d)/d$$

- The engineer determines the required liner thickness d based on liquid depth H and liner permeability k .
- Decreasing liner permeability coefficient k by increasing liner compaction or using a soil amendment decreases the required liner thickness.
- Decreasing liquid depth H reduces the required liner thickness.



Siting Considerations Earthen Impoundments

Separation Requirements

Buffer distances

- Reduce impact on non-owned dwellings
- Use judgment for distance (wind direction, topography, character of landscape etc.)



Satellite Storage

- Quick Empty
- Better location
 - To empty
 - For earthen
- Cost to transport (twice)
 - Neighbor concerns



Siting Controversies

- View
 - Access
- Satellite storage
 - NIMBY
- Safety
 - Gases and pathogens
- Odor

Access Road

- Longer
- Unload and Load
 - Pumping
- Outlet to public road

Air Drainage

- Still Summer nights
- Cool area “drains” downslope
- “Pools” around houses
- Can be diverted with hedges
 - Time to grow?

Impacts of Climate Change?

- Severe storms
- More total precipitation

Climate Assumptions

- Climate Change
 - Wetter winters
 - Variability
 - Winter melts
 - Summer droughts
 - Intense storms

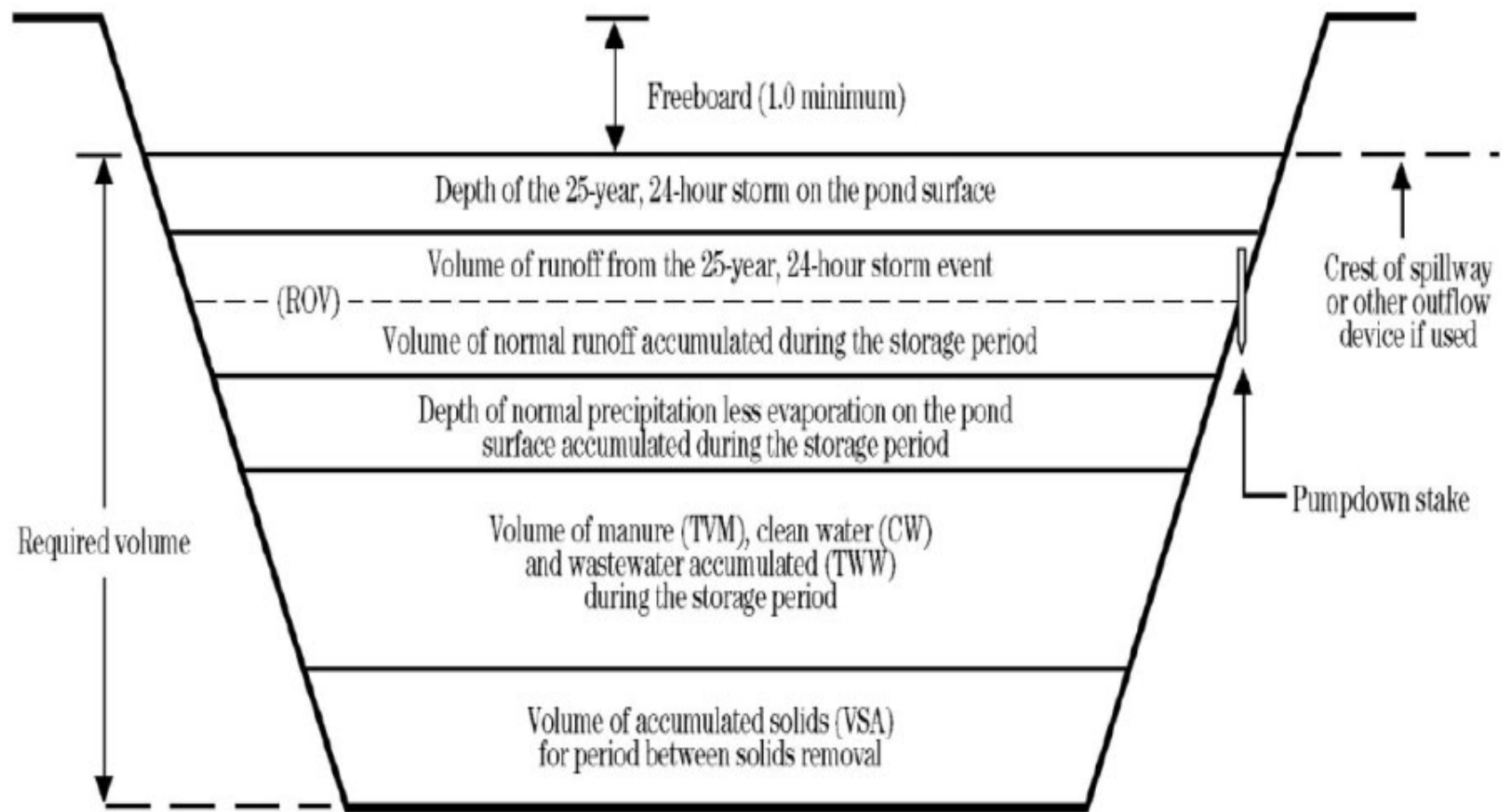


Figure 1. Cross section of waste storage pond with watershed (USDA-NRCS, 1997).

Summer Spreading

- After Hay Cuttings
 - Odor
- Growing crops
- Double cropping





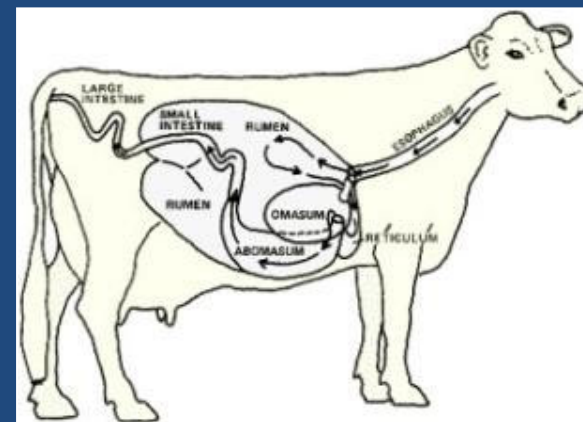


DAIRY FACILITIES AND GHG EMISSIONS

Carbon Dioxide (CO_2)

Methane (CH_4)

Nitrous Oxide (N_2O)

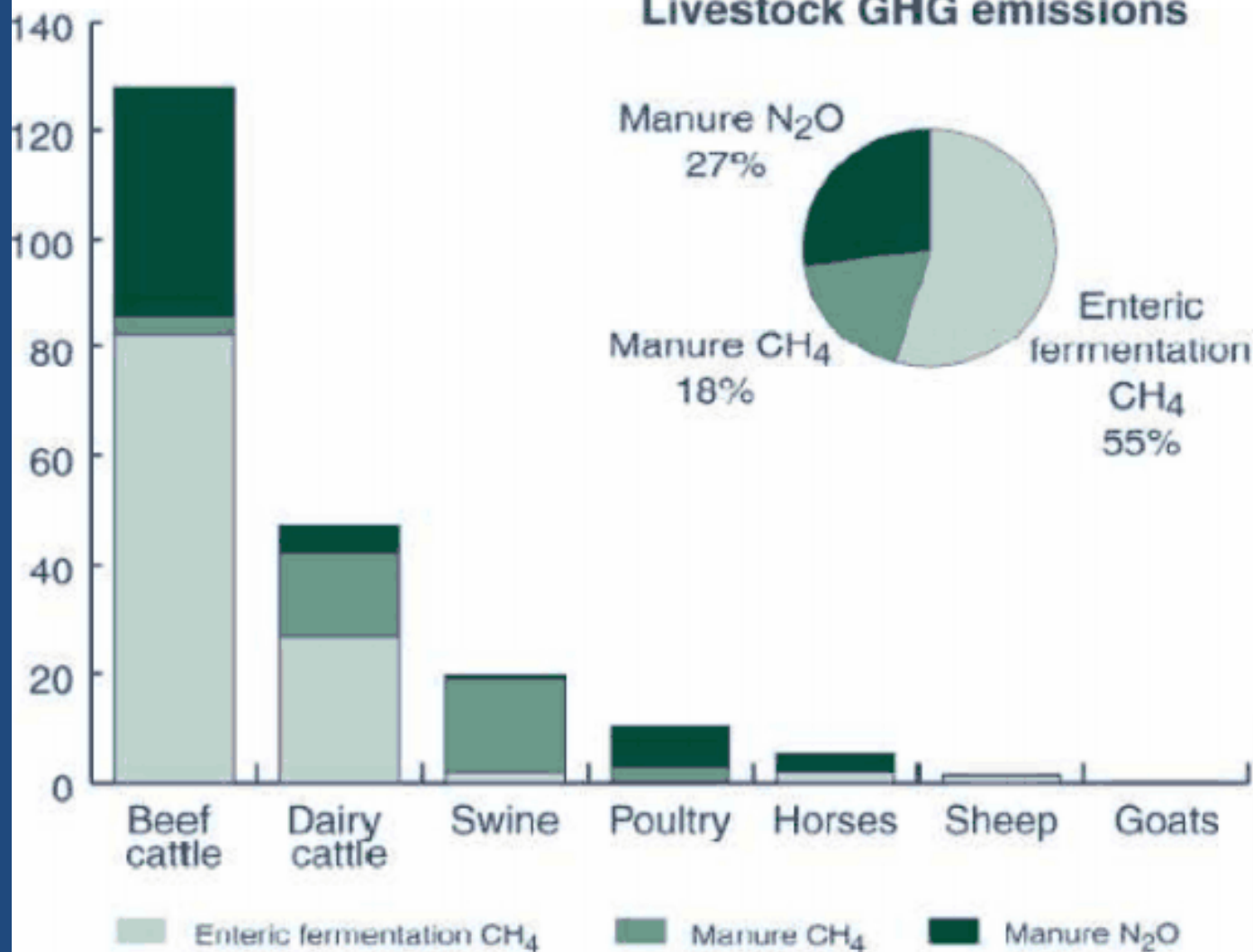


Credit: University of Minnesota

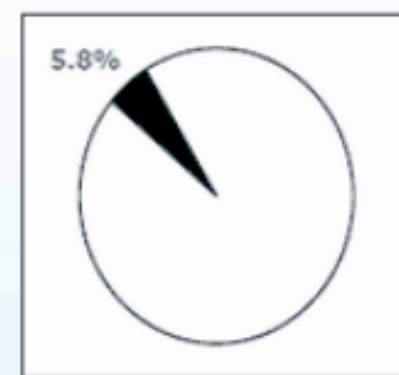
Tg CO₂ eq.

Livestock GHG emissions

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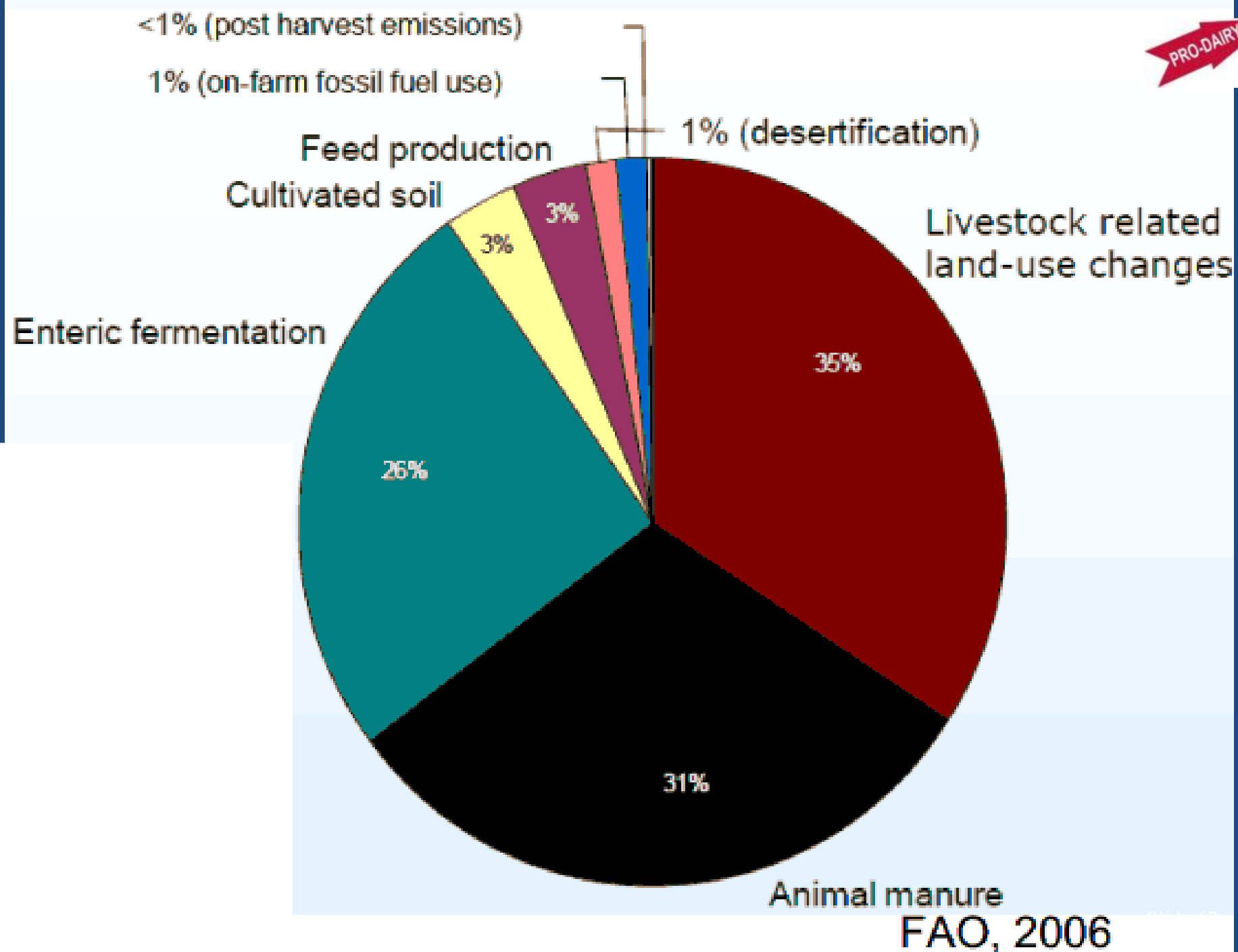
USDA, 2004



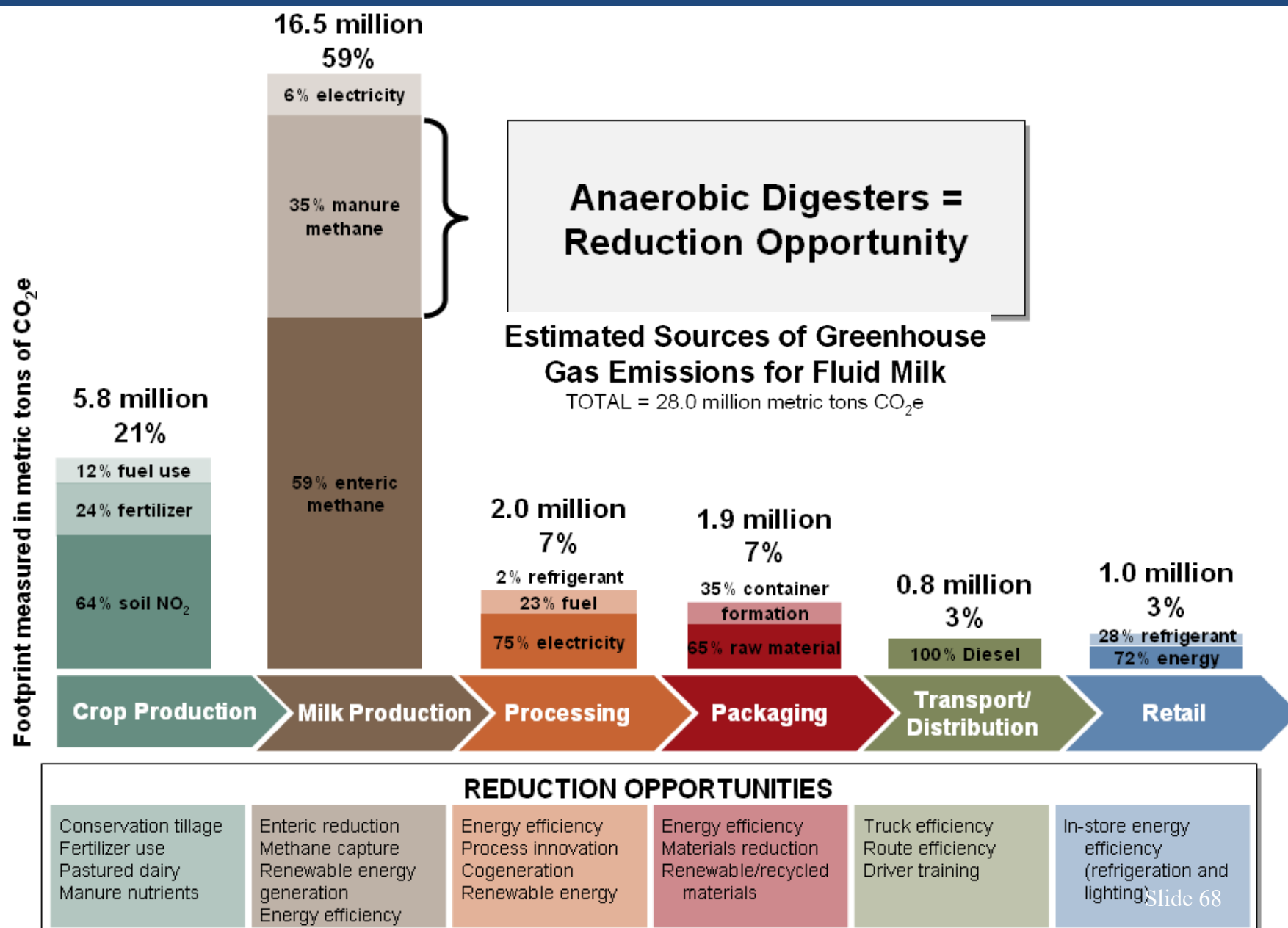
Agriculture as portion of emission:
414 Tg CO₂-eq yr⁻¹

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Estimated Sources of Greenhouse Gas Emissions for Fluid Milk



Water Quality vs GHG

- Methane from storage
 - 1.36 metric tons CO₂eq/cow per year
- EPA's Societal Carbon Cost
 - \$47/ton CO₂eq
- 500 cow storage creates \$27,000/year externality
- Water Quality benefit?

Storage Covers

- Precipitation control
 - Less storage needed
- GHG collection
- Solid Separation
 - Less storage needed



Safety

- Fence
- Signs
- Rescue Equipment
- Barrier
- Gases
- Confined space

Safety in Manure Storage Facilities

- Fencing prevents unwanted entry by humans or animals.









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Safety in Manure Storage Facilities

- Grates should be provided over sumps and reception pits to prevent accidental entry.



Safety in Manure Storage Facilities

- Stored manure generates hydrogen sulfide and other toxic gases that may be hazardous under certain conditions.
- Agitation can release gases in high concentrations.
- Humans and animals should not be near a manure tank being agitated.



Safety in Manure Storage Facilities

- When agitating an underfloor pit, provide maximum building ventilation.
- If human entry in confined space is absolutely necessary, use a self-contained breathing device and the buddy system.



Conclusions

- Policy and Society Changes
- Storage needs increase
- Manure storage is a major investment
- Manure storage requires management
- Plan with producer and engineer

Construction Inspection

- Inspection Plan
- QA/QC
- Changes

Construction Inspection/Quality Assurance

- Insure that a project is installed at the location and to the dimensions and grades using the construction materials specified in the plan.
- Verify work complies with the contract requirements or minimum (eFOTG) standards.
- Required for completion certification.

Quality Assurance

National Engineering Manual (NEM) 512.31(B)

- Activities performed by or for the owner including: observing construction methods and procedures, reviewing quality control testing activities of the Contractor, conducting material testing to evaluate Contractor's quality control system, and other measures to ensure compliance with the contract provisions.



Key Steps List

AGRICULTURAL ENGINEERING SERVICES, PLLC

Step	Notification Timeline	Completed
1) Pre-construction meeting with contractor	Minimum 24 hours prior to the start of construction	
2) Notification of commencement of construction	Minimum 24 hours prior to the start of construction	
3) Completion of site preparation, including organic and topsoil removal	Upon completion, but not less than 24 hours prior to start of site work	
4) Completion of excavation for manure transfer pipes and manholes	Upon completion	
5) Placement of precast manhole structures	Minimum of 2 days prior to installation	
6) Installation of manure transfer pipes	Minimum of 2 days prior to installation	
7) Core drilling of existing manure storage and installation of steel wall sleeve and 36" pipe	Minimum of 2 days prior to installation	
8) Completion of the project including grading and seeding of all disturbed areas	Upon completion	

Construction Inspection Plan

Purpose:

The purpose of this construction inspection plan is to ensure that the farm receives quality construction of the practices that will meet NRCS Standards. In order to ensure the construction of the practices are completed according to the designs the farm must be involved in the construction process and interact closely with the construction inspector from Agricultural Engineering Services, PLLC.

Farm's Responsibilities

- The farm shall become familiar with the design to understand what is to be completed within the scope of the project.
- The farm will contract with an experienced installer to complete the project according to the drawings and specifications.
- The farm will call the engineer indicated on the key points list below. The engineer will be notified within the number of days or hours indicated below to allow for inspection to be completed on integral parts of the construction.
- Should the farm have questions or concerns about the design or construction of the project they will immediately notify the engineer. This includes problems that arise during construction that are not on the key points list below.
- It is imperative that any changes to these drawings during installation be approved by the engineer prior to implementing.
- Accurate as built drawings documenting construction must be prepared at the completion of the project.



Engineer's Responsibilities

- The engineer will determine at which key steps inspection is required.
- Should problems be encountered during construction the engineer will respond to questions within 24 hours. If a site visit is required to solve the issue the engineer or his designated representative will be on site within 48 hours. If a meeting is required between the engineer and contractor the 48 hour limit may be exceeded to allow for scheduling conflicts.
- The engineer or his designated representative will complete a final inspection of the project prior to the contractor leaving the site.

512.51 Scope:

As-Built records must be prepared for:

- Practices such as dams, diversions, dikes, grade stabilization structures, waste storage facilities, and waste treatment lagoons which could endanger human life or cause significant property or environmental damage if they should fail.

GEOLOGY

- Important to Compare What is Actually Found at the Site During Construction to What was Assumed in the Design Phase

All Significant Differences Shall be Reported to the Approving Engineer

- Also, They Must be Described and Noted on the As-Built Drawings for Later Reference

As-built plans

Part 512 NEH (adopted for conservation practices)

- Geologic investigation report
- Soil mechanics report
- Design report and design folder with pertinent calculations
- Construction and material specifications
- Material certifications and construction tests
- Construction photographs
- Job diaries and engineering field notebooks
- Pertinent correspondence
- Contract modifications and final contract payment estimate
- As-built plans

As Built Plans: Value to farm

- Permit documentation
- Resale, next generation
- Unseen features
- O&M, modifications, updates

512.52 Documentation

- Recording Changes: The Engineer of Record will be responsible.
- Labeling: The as-built drawings must be marked “AS-BUILT”, list the contractor, QA personnel, construction completion date, and signature of certifying official.

As-built drawings should contain the following as applicable:

- All final elevations (structural, pipe invert, etc.) and measurements
- Locations of structural elements and appurtenances
- Locations of utilities discovered during construction
- Any substituted materials
- Any major geologic differences encountered during construction
- Locations of survey points not included on the original drawings
- Name of contractor (statement that landowner performed the work)
- Any other pertinent information that may be useful at a later date
- For small projects where no changes were made during construction an as-built may be as simple as a copy of the original drawings stamped “As-Built – No Changes During Construction” signed and dated by the individual approving and certifying the installation.

Documentation

- Red ink pen (or red lines in AutoCAD) shall be used for recording changes.
- All changes in notes, measurements, elevations and other details shall have the original crossed out with a single line and the as-built value written adjacent. Example: elev. ~~23.6~~ 24.5 The individual certifying the as-built drawings must initial each sheet of the drawings.
- sign the title sheet with the following statement:
“I certify that to the best of my professional knowledge, judgment, and belief these practices were installed in accordance with the plans and specifications and meet NRCS Standards.”

512.53 Disposition

- Paper or electronic copies.
- Retained in field office for the life of the practice.
- A copy of the as-built drawings should be provided to the owner.

QUESTIONS?

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